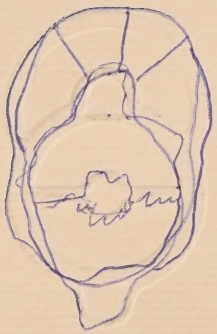
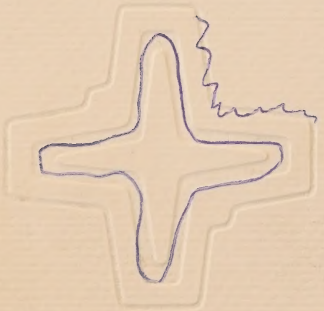
MOTOROLA ANNUAL REPORT 1961





A Progress Report...Integrated Circuitry

The Cover designs symbolize three basic integrated circuit technologies through which Motorola is gaining leadership identification in the art of solid state electronics.

The *circular* design represents a ferrite logic core. With the addition of wire windings, this multi-aperture device becomes a complete circuit for a digital computer. A star planar transistor—the *center* design—symbolizes the epitaxial technique of growing crystals on substrates. The *rectangular* design illustrates the configuration of most integrated circuits of the future.

Motorola's work on such integrated circuits involves a synthesis of the sciences of chemistry, physics, metallurgy, mathematics, and electronics. The arts and skills required in semiconductor processing, thin film technology, surface passivation, and electronic ceramics are based upon these sciences.

Through the combined efforts of many specialists working in the Motorola research laboratories, substantial advances have been made in the practical production of the integrated circuit equivalents of resistance, capacitance, and inductance. Multiple circuit elements are being produced in semiconductor substrates by means of diffusion, alloying, and epitaxial growth, and upon insulator substrates through the use of vapor deposition and advanced thin film techniques.

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HIGHLIGHTS OF 1961

Business "Dispatcher" two-way mobile radio introduction.

Motorola equipment for NASA space vehicles.

Record level in foreign sales and licensing income.

Electronic alternator and ignition systems for automobiles.

Third consecutive Mahogany Association Award for furniture craftsmanship.

Application of epitaxial and planar production techniques to semiconductors.

"Extender" noise suppression circuit for MOTRAC two-way radio.

Modern communications system for Chicago Police Department.

All-transistor aircraft flight control system.

Divisional status for Solid State Systems.

TO THE SHAREHOLDERS

The mood and dynamics of Motorola's markets changed dramatically from the early to the latter part of the year. The hesitancy of the consumer to purchase durable goods and the indecisiveness of the commercial and military buyer during most of the first half of 1961, are well known.

In contrast, as the year ended the consumer was displaying a confident mood...the industrial market firmed . . . and military programs were expanding. This uneven tempo of business was the biggest single influence on 1961 earnings which declined to $2.36 per share compared with $3.14 in 1960.

In addition, special circumstances in the semiconductor market are significant. Competition was intensified by industry overcapacity for many devices, less than anticipated demand in certain areas, and substantial erosion of prices through the year. In spite of this, Motorola's Semiconductor Products Division increased its dollar volume considerably and maintained virtually the same excellent profit it reported in 1960.

Also noteworthy, sales volume and licensing income from our international operations were up 24%, and earnings more than doubled.

The improved momentum in practically all of Motorola's markets—well in evidence as the year ended—promises better volume and particularly better earnings for the Company in 1962.

At the close of 1961, field inventories of consumer goods were moderate, making it possible for distributors and dealers to add to their stocks. Motorola's share of the television and phonograph markets was steadily growing. Automobile sales were continuing at a brisk pace through the winter; car radio volume was up accordingly.

Though temporarily slowed early in 1961, the Communications Division continued its uninterrupted year-after-year pattern of sales increases, and confidently predicts further gains in 1962. Unit and dollar volume in the Semiconductor Products Division are mounting though cost and price pressures will make it difficult to maintain last year's fine profit record. We look forward to perhaps a 30% increase in military sales for 1962.

More product developments and scientific achievements of significance matured in 1961 than in any other year in our history. The most long range of these are in solid state electronics. Our achievements in molecular structures, integrated circuits, solid state process controls, and a variety of solid state devices have made it appropriate for us to establish a sixth important Motorola division called the Solid State Systems Division. In addition, we announced many other developments with more immediate potential.

I call your attention to our balance sheet which for the first time consolidates Motorola Finance Corporation. Much of the long and short term debt is for the purpose of financing the $40,000,000 in notes and contracts owned by the finance company. Two-thirds of last April's $30,000,000 public issue of debentures was for this purpose.

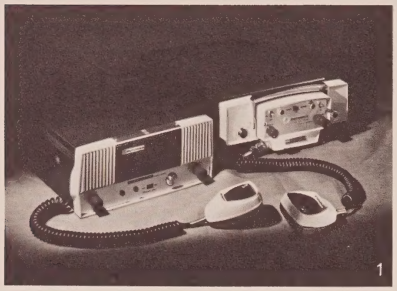
In general, markets for all of Motorola's products will be larger and more orderly in 1962. Your company is ready to take advantage of its opportunities, and this is evidence of the achievements and imagination of my associates.

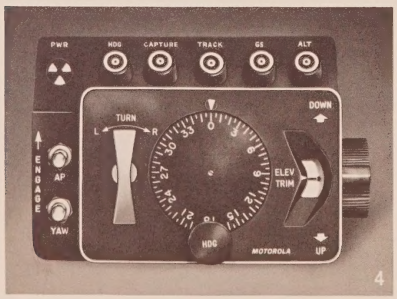
For the Board of Directors

Robert W Galvin

March 13, 1962 *President*

COMMUNICATIONS DIVISION





Most prominent of the communications products introduced in 1961 are: **1**/ the Business "Dispatcher" two-way mobile radio (left)—together with the well-known MOTRAC radio featuring the new "Extender" noise suppression device • **2**/ the Low Frequency Pocket Radio Pager (right)—smallest yet of Motorola's family of pocket radio products • **3**/ new closed circuit TV control panel, monitor, and transistorized camera • **4**/ all-transistor flight control system • **5**/ control center for Motorola-built Chicago police communications network.

The Communications Division increased its lead in the two-way radio field despite intense competition in 1961. Sales volume increased and earnings kept pace, aided by the introduction of new products and continued attention to control of costs.

Major performer in the product line continues to be the transistorized MOTRAC two-way radio. New products and improved features introduced in 1961 both strengthened the Division's position in the market and provided a broader base for good performance in 1962.

The Division's aggressive program of research and development resulted in introduction of two significant mobile two-way radio products this past year. In spring, the "Extender" circuit—an ignition noise-suppression device—was introduced as a built-in optional feature of the premium quality MOTRAC two-way radio. Appreciable improvements in communications range and quality result from this circuit which detects and cancels "noisy" ignition pulses. Early in 1962, the circuit in slightly modified form will be offered in an adapter kit for Motorola mobile units already in use.

An entirely new mobile two-way radio, designed primarily for the general business market, was the second significant product development. Called the Motorola "Business Dispatcher" radio, the new unit includes a fully transistorized receiver and power supply economically designed for the smaller business organization. Its features are exclusive to Motorola within its price range.

Noteworthy this past year was the completion of a $1.5 million communications network system for the City of Chicago Police Department. The system represents the largest single order for a two-way radio system ever received by the Division. It provides Chicago a completely new and modernized police radio network, incorporating new equipment and operational concepts with broad potential for similar application in major cities throughout the U.S.

During the latter part of the year, a new pushbutton mobile radio-telephone, combined with Motorola's exclusive transistorized MOTRAC radio unit, was introduced to the independent telephone market.

A new remote control closed circuit television console was announced during the year and development of a transistorized camera and monitor was completed. Both will be marketed in early 1962.

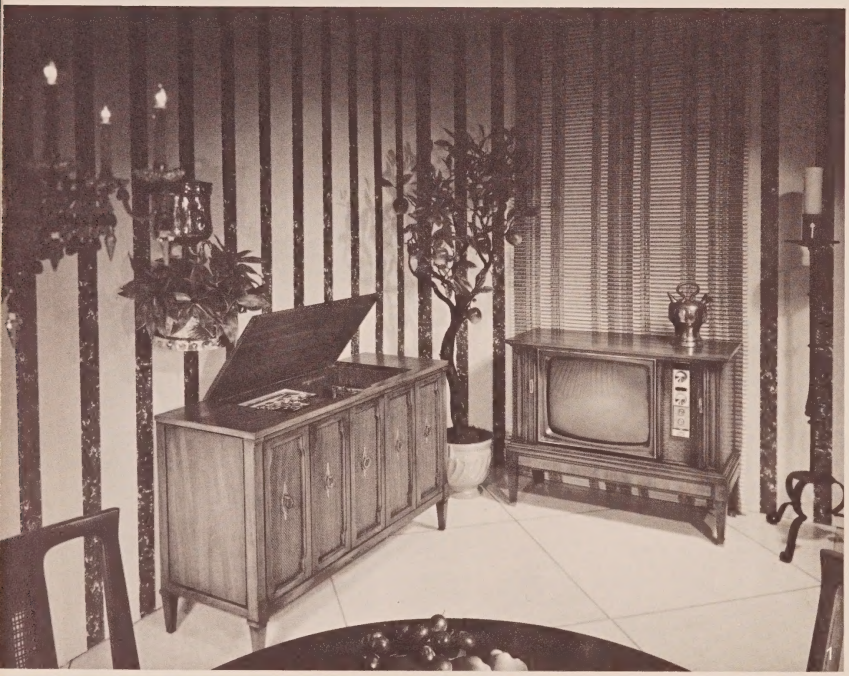
In the miniature equipment field, a new Motorola "Low Frequency Pager" was introduced. New transistor techniques permitted significant advances in miniaturization, reliability, and operating characteristics. This new pocket radio pager is smaller and lighter and has a substantially reduced operating cost as compared with previous pagers. To meet demands of hospitals and industry for larger systems, a high capacity, low frequency base station was engineered with a capacity of up to 900 units.

The miniature product line also contains the VHF radio paging system and the fully transistorized "Handie-Talkie" Pocket Transmitter and Pocket Receiver. During the year several systems of note were completed—such as a city-wide medical paging system for the San Diego, California, county medical society; and two-way networks for foot patrolmen in Washington, D. C., and other major cities.

Motorola radio traffic control systems were installed in Hartford and New Haven, Connecticut, during the year and orders were received for new systems from the City of Tampa, Florida, and the New Jersey Turnpike Authority.

The ADF-T-12 all-transistor automatic direction finder, a product of the Division's Aviation Products Department, continues to dominate the market for this type of equipment. The new M-4 all-transistor flight control system—announced during September—already has a reputation as leader in the general aviation "automatic pilot" field.

CONSUMER PRODUCTS DIVISION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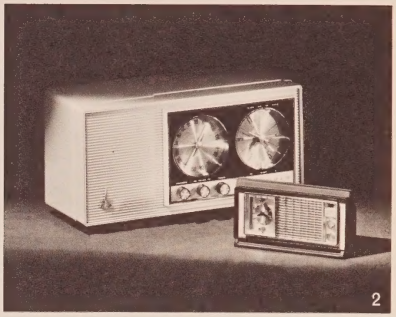
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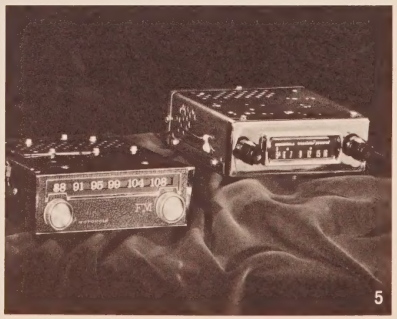
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Available to Motorola customers is a full line of home entertainment and car radio products. It consists of: 1/ television receivers and stereo hi-fi phonographs—featuring the well known Drexel and Heritage furniture designs • 2/ clock and table AM and FM radios 3/ portable radios — including the popular pocket-size units • 4/ portable transistorized TV • 5/ FM and AM car radios and tuners. Motorola, for the third consecutive time, has won the Mahogany Association "Grand Award" for outstanding furniture craftsmanship.

The consumer, anxious about international tension and the business recession, milled around the market place in early 1961 with his money cautiously banked. As a result, many consumer durables fell short of their prior-year levels. Automobiles, television receivers, phonographs, radios, household appliances, and others, all suffered in varying degrees in the first half-year.

The early decline for Motorola consumer products was reversed from mid-year on with sales showing steady improvement during the third and fourth quarters. The comeback was not quite sufficient, however, for the full year to equal 1960, although the fourth quarter ran at a substantially higher level than in the previous year.

Distributor sales volume increased considerably in the last two months, particularly in the major dollar product categories. TV was up 22% over the like period in 1960, and stereo phonograph sales increased 32%. Home radio maintained the same unit volume. Car radio was off somewhat, being unable to meet the surge in demand during this period. This, however, precipitated stepped-up production which will be reflected in wide first quarter increases.

A sharp uptrend was generally evident going into 1962. Both sales and earnings in the consumer products area are expected to show satisfactory increases for the year as a whole.

During 1961, several television manufacturers marketed color receivers using the early-design 21-inch, 70 degree, round picture tube. This tube is the only one currently available and requires a bulky cabinet to house it. Motorola chose not to re-enter the color television market with this approach, convinced that the sales volume would not be adequate for a profitable venture. This proved prudent. The industry color television retail volume for the year was an estimated 170,000 units, less than 3 percent of the some 6,000,000 black and white receivers sold.

To encourage the industry to modernize color television, Motorola's engineers designed and built a working prototype, 23-inch, 90 degree, rectangular color tube. This tube made possible a cabinet of the same size and attractive design as current black and white receivers. The set was demonstrated throughout the country and the tube technology was offered to the entire industry in an effort to attract a tube manufacturer to produce it. At year end, however, no major manufacturer had agreed to make the tube, although the possibility still exists in 1962.

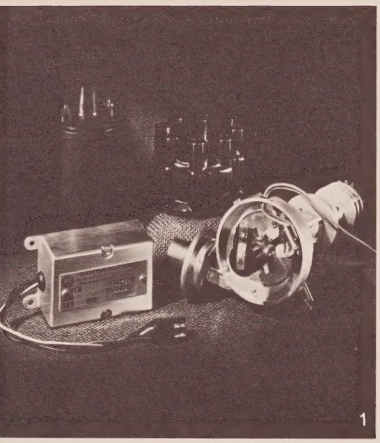
The Company continues to believe that color will become an important product and a source of greater enjoyment for viewers.

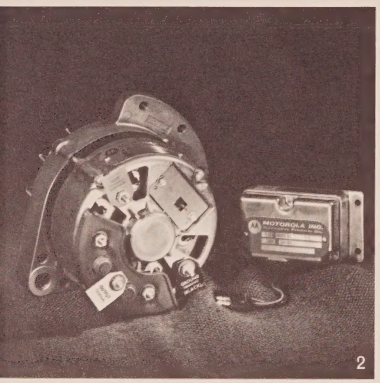
Motorola also took a strong stand against "gimmick" merchandising methods such as the "Instant Dividend Plan" sale of television receivers and stereo phonographs through grocery stores.

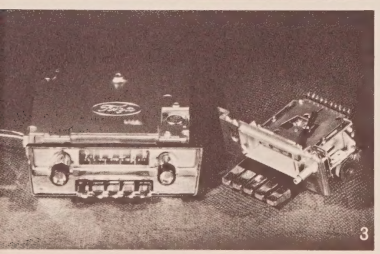
Motorola completed in 1961 its third year of association with the Drexel Furniture Company and Heritage Furniture, Inc., winning increased recognition for excellence of furniture styling and quality. In the latter part of the year, during the Chicago Furniture Market, the Division held a private showing of 14 unique and original furniture creations incorporating Motorola radio, stereo hi-fi, and television units. These unusual designs, featuring Drexel and Heritage styling and called the "Designer-Decorator Series," include furniture pieces such as coffee tables, serving carts, breakfronts, and hanging wall decks—each housing Motorola radios, TV's, or stereo phonographs.

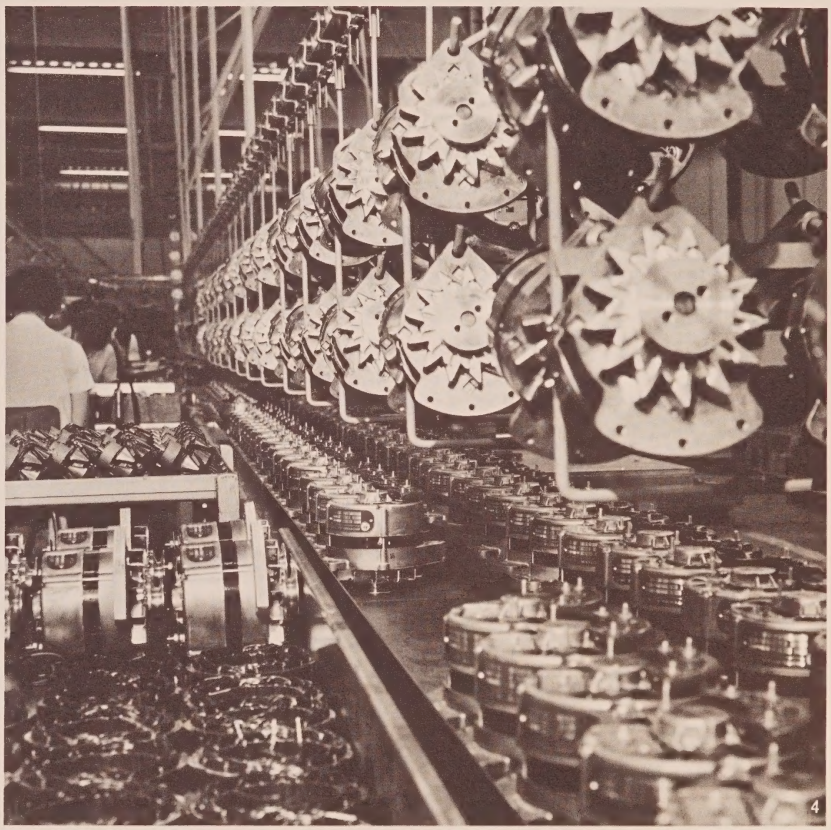
During the summer, the Company discontinued its display space in Chicago's Merchandise Mart. Negotiations were completed at year-end to open a new salon on the ground level of the well-known Palmer House in Chicago. It will front on State Street a few doors south of Madison—considered one of the world's busiest sidewalks.

AUTOMOTIVE PRODUCTS DIVISION









Diversification into new product areas, and production of fully-transistorized car radios were two of the major milestones in 1961 for the automotive group. New product developments were: 1/ the transistorized ignition system; and 2/ the all-electronic alternator system with voltage regulator. A miniature tuner 3/ (right), has replaced all other type tuners in Motorola auto radios such as the all-transistor radio shown (left) · 4/ Long lines of alternators move along conveyors at the recently expanded Arcade, N.Y., production facility.

Sales volume of the Automotive Products Division decreased substantially in the first six months because of reduced output in the automobile industry. With the introduction of 1962 models, however, sales returned to a favorable level. Increases are anticipated for 1962 both in car radios and in the significant new automotive products announced during the past year.

In its more than 30 years in the car radio business, Motorola's automotive group has been involved almost exclusively with designing and building radios for automobiles. Announcements in 1961 of new electronic devices to be manufactured for the modern auto marked a noteworthy transition in product diversification for both the Company and the Automotive Products Division.

In September, Motorola introduced an all-electronic alternator system to replace the DC generator and voltage regulator in the automobile. The system, using transistors and diodes exclusively, is designed for maintenance-free operation and extended life. It enables the battery to charge while the motor is idling even with the high electrical current demand of many accessories in operation.

The alternator extends battery life from 25% to 50%, and has particular application in service vehicles which can become costly overhead when inoperable. The system is specially suited to such vehicles as taxi cabs, delivery trucks, farm equipment, and patrol cars which operate for long periods at low speeds and are continually stopping and starting.

A second electronic device, a transistorized ignition system, was announced in November. The system completely eliminates the breaker points and condenser in the distributor. It replaces them with a small magnetic pick-up system which will last the lifetime of the car and does not require the maintenance or adjustment of present ignition devices.

The alternator and ignition systems were made possible through advances in the transistor and diode art accomplished by Motorola's semiconductor group in Phoenix.

The Automotive Products Division is now offering a unique reverberation system for automobile radios. It is the first mass-produced reverberation system designed for passenger cars, making available "concert hall" radio performance while driving.

The complete transistorization of car radios has become economically practical and the Division has now converted to mass-production of an all-transistor auto radio. The automotive industry is headed for fully transistorized car radios in virtually all 1963 models.

In 1961, Motorola supplied all-transistor radios both for the Lincoln-Continental and the Ford "Thunderbird" models. These have been continued in the 1962 models. Ford Motor Company initiated a change during the year to complete transistorization for most of the 1962 model radios manufactured by Motorola. The "Rambler" car radio is now completely transistorized, as well as radios produced for the Renault Motor Company.

The Automotive Products Division continued to supply radios to Ford, Chrysler, and American Motors in 1961. The total radio requirements were supplied for Ford's "Thunderbird," "Galaxy," "Continental," "Meteor," and "Comet"; American Motors' "Rambler"; Dodge's "Lancer," and Plymouth's "Valiant"; Renault (U.S. sold); and International Harvester.

Automotive Products Division business for the first time became international upon negotiation of a joint venture agreement with a large automotive parts manufacturer in France. A newly formed company will produce Motorola electronic alternator systems for the European market. In addition, samples of the Division's automotive products have been submitted to countries in other parts of the world in prospect of establishing similar joint venture agreements.

SEMICONDUCTOR PRODUCTS DIVISION

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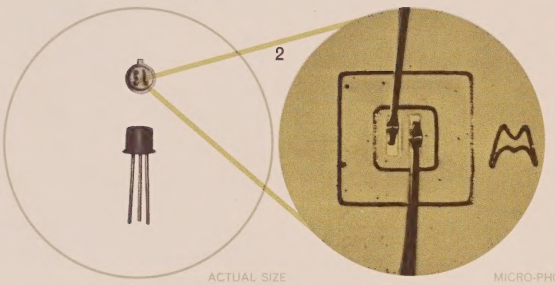
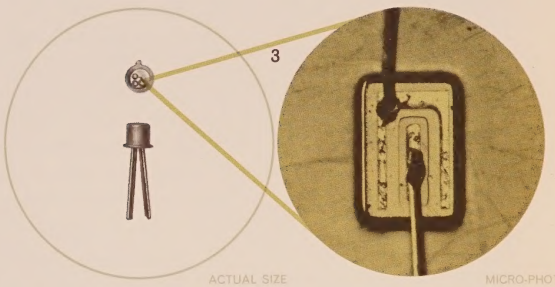


2 ACTUAL SIZE MICRO-PHOTO



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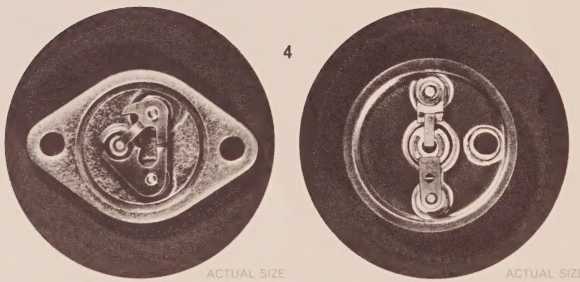

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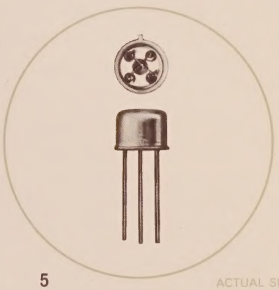

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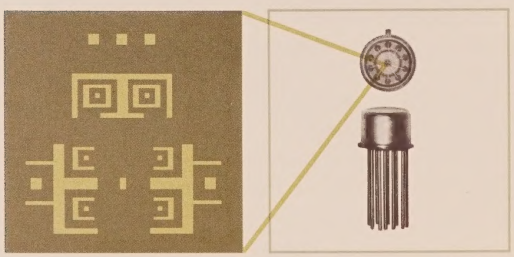
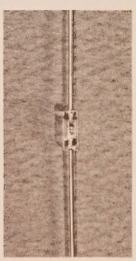


6 ACTUAL SIZE

The success of Motorola's semiconductor business in 1961 was due for the most part to eight particular types of devices. These are illustrated on this page. Actual size photographs indicate the tiny dimensions, and microscopic photos show the minute circuit function areas not visible to the eye: **1**/ epitaxial star planar transistor · **2**/ germanium epitaxial mesa transistor · **3**/ silicon epitaxial mesa transistor · **4**/ power transistors · **5**/ general purpose milliwatt transistor · **6**/ integrated "flip-flop" circuit (diagram and actual size) · **7**/ zener diode · **8**/ automotive silicon rectifier.



7 ACTUAL SIZE

8 ACTUAL SIZE

national MOTOROLA RADIO COMMUNICATIONS service

The DISCRIMINATOR

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VOL. 6
NO. 1

TWO-WAY RADIO AS A PROFESSION

By JOHN TANSEY
National Service Manager

The two-way radio serviceman is a member of a select group. First, he must have his FCC license in order to service equipment. Second, he is performing a vital service for business and government organizations. He is servicing equipment that is essential to the efficient operation of these organizations. Failure of the equipment might not only prove costly to the user, but, under some circumstances, could also have great effect on life and property.

A survey that we made sometime ago indicated the professional attitude of Motorola Service Stations. Just about everyone subscribes to technical magazines to keep up with advancements in the electronic art. Interestingly enough, one out of every eight Service Stations mentioned reading The Institute of Radio Engineers Transactions.

Of special interest to you is the Professional Group on Vehicular Communications which is operated by the IRE. The PGVC, as it is commonly known, was established because land-mobile radio service is one of the most rapidly growing services in the field. This group was formed to disseminate the increasing knowledge of this field and to promote a free exchange of ideas, thoughts, and experiences.

There are local chapters from coast to coast, and the number has grown. They represent closely knit groups which meet frequently to engage in active discussions on topics related to this field. Membership in such a group can do much to expand your mental frontiers as well as prepare you for new advances in electronics.

You can obtain more information concerning the IRE and PGVC by writing to: L. G. Cumming, Technical Secretary; IRE Headquarters; 1 East 79th Street; New York 21, New York. » » »

MOBILE COMMUNICATIONS SERVICE
TOPEKA, KANSAS

When it first became an authorized Motorola Service Station, a decade ago, the Mobile Communications Company of Topeka, Kansas, was firmly convinced of a rosy future in the growing two-way radio servicing business. These expectations were more than realized, and the company's history in this field is one of continuous expansion and greater operational success.

Optimism is still the watchword for officials of the firm, and they now foresee eventual adoption of 2-way radio by many more of the businesses in their area. Shop and field servicing facilities at the company are already geared for maximum efficiency and a branch operation is already firmly established.

There are some important reasons for the rosy outlook held by its owners, James W. Frazee and Charles E. Holman. From its original $40 a month contract business at its start as an MSS on December 27, 1948, the firm has grown to a point where it services hundreds of units. Its initial investment of $165 in parts now has grown into a complete stock inventory running into thousands of dollars.

As partners in the company, Holman and Frazee have combined business acumen with technical knowledge to good advantage. Holman, an alumnus of Washburn University in Topeka, has been Vice President and General Manager of Topeka Yellow Cab Company for the past 10 years. His background includes seven years of service as County Clerk of Shawnee county and a four-year stint as Vice President of the Topeka Savings Association.

Jim Frazee (left), partner in the Mobile Communications Company of Topeka, Kansas, and Ed Vaughan, District Service Manager for Motorola, discuss entries in a Service Call Sheet.

Exterior view of the Communications Company's building, showing one of the radio-equipped service vehicles used to provide fast customer service in the field.

Frazee served in the Army Air Force as a Radio Technician and has a long record as a radio servicing technician. He provided technical radio knowledge and served as dispatcher for the Yellow Cab Company. He has been a ham operator since 1946, with station call letters WØSSB. He has been a member of the Institute of Radio Engineers for the past two years. Frank Fernald, shop foreman, and technicians, Robert Gibbs, and Earl N. Jahnston, make up the staff.

An indication of the confidence these entrepreneurs have for the future of their business was manifested in July 15, 1958, when the firm moved into its new building at 125 Jackson Street in Topeka. This structure is designed expressly for 2-way radio servicing. It is a drive-through building, 35 x 60 feet, with a 12-foot overhead

(Continued on page 6)

IMPROVING TROUBLESHOOTING METHODS

By FRANK A. BRAMLEY

New England District Service Representative

It is advisable in any endeavor to take stock once in a while and consider what improvements might be made in an operation that would be really worthwhile. Are you really doing the best possible job in the least possible time? Are you really clearing all the troubles on the first or second attempt, or are you talking yourself or the customer out of it? Do you have a few customers who have imaginary troubles or think up troubles just to annoy you? If you are uncertain of the answer to any of these questions, perhaps this article can help you.

In the author's more than 30 years of experience in radio troubleshooting, he has never found a customer who could be accused of lying about an equipment trouble. This is a remarkable fact, well worth considering, because there have been numerous occasions when all of us found difficulty in locating any definite cause of fault in equipment.

In our frustration, we quite naturally wondered whether the trouble really existed. It was so easy to put together a case that would explain the customer's aberrations that we frequently found ourselves doing that rather than trying to devise better ways to locate the trouble that usually was there.

In the author's experience, every complaint has had a cause, even though it may have taken months to find the trouble. If you have many seemingly untruthful or unreasonable customers, perhaps what you really need are better troubleshooting techniques. May I suggest that you incorporate the following seven basic rules in your service procedure the next time you encounter one of those sticky problems.

Rule No. 1—Listen to Your Work—You May Hear Something Interesting.

Failure to actually monitor on a 2-way radio system has often been a factor in failing to find trouble quickly. Thousands of units have been installed without the serviceman listening to determine how the equipment sounds with the engine running and the vehicle moving down the street. Many an installer would not be proud of his work if he did listen as the user does. Many a base station transmitter trouble has not been found because the technician had no easy way to listen to it or did not take the trouble to do so.

The listening test, although important, is seldom resorted to except as an afterthought or accident. Operators are seldom technical men and cannot describe the trouble as you would, and even when they try, their inaccurate use of terms may send you astray or miles away from the real trouble. By listening, with your own ears; it may then be easier to believe the customer's complaint. You may save yourself hours, dollars and customers.

Examples: Excessive hum modulation is not easily recognized or described by many users. Over deviation, excessive limiter clipping, improper use of microphones, amplitude instead of frequency modulation and countless other troubles are easily recognized by the technician, but difficult to describe by the user. Telephone line hum, tube noise, microphonics, various forms of static and interference are a cinch to recognize if you are an experienced technician. How will you know unless you listen?

There are other ways and places and means of listening too. A pair of crystal headphones should be a part of every tool kit. They may be momentarily connected anywhere and you may be surprised at what you hear in unexpected places. Example: Suppose you know there should be a certain amount of tone on a terminal and you have measured it with a VTVM and found it to be present as required, yet the equipment does not work. Listening with Crystal phones may reveal that the "tone" is 60 cycle AC.

An oscilloscope would show this, if you took the time to measure the frequency, but the phones are much quicker. Momentary connection of the phones to plate voltage does no harm and you may hear various things that should not be present. In general, plate supplies should be "clean" —no excessive tube noise, no hum or vibrator hash. There is room for a lot of variation here, especially if you consider very low levels, but experience will tell you when the levels are too high.

Ordinary phones may not respond to very low or very high frequencies, which may be the cause of your troubles, and magnetic phones cannot be connected across high impedance or high voltage circuits without causing trouble. Even with the crystal phones, use series condensers and be careful of high voltage circuits. The difficulty with audio signal tracers is that they may respond to levels so low as not to really count and you find yourself looking for troubles that are not important. Using crystal headphones you can trace any audible signal without batteries or AC power and easily get an idea about strength, frequency, noise content and distortion.

One of the most exasperating troubles concerns transmitters that radiate on undesired frequencies. A common cause of this is failure of the bypass capacitors associated with the oscillator/modulator/audio circuits to do their job properly. This may be due to leakage or simply a breakdown.

The capacitors in question are usually electrolytic and should have been provided with a ceramic or mica condenser in parallel to assist in bypassing high fre-

SIGNAL GENERATOR RECOVERED.

Police in Miami, Florida, have recovered a TU 576 Signal Generator, Serial No. 1483. The owner can claim this unit by contacting the Miami police or by contacting Rod Mulford, c/o Motorola, Room 502, Professional Bldg., Ft. Lauderdale, Florida. » » »

SERVICE PROBLEMS & SOLUTIONS

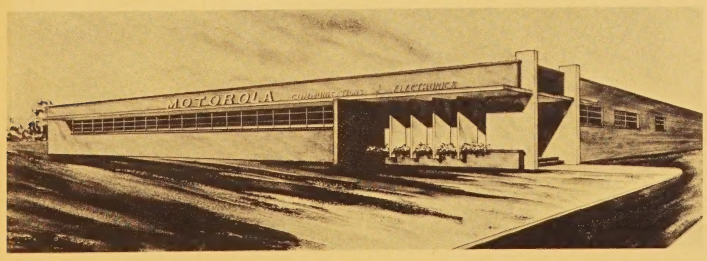
MODEL	TROUBLE	ANALYSIS AND REPAIR
FMTR80D (A)-1-C	Low Receiver Sensitivity	Discriminator will not zero. Replaced shorted C-70 Capacitor
TA161	Squelch "chatters" on Threshold Setting	Replaced Leaky Capacitors C167—C156
FMTRU41V (AF)-1-C	No Squelch	Replaced Defective Discriminator Coil and Shorted C83 Capacitor
T43GGV-1	Low Sensitivity (or Low Gain)	Air Leak in "IF" Tube. "IF" stages out of Alignment. Replaced Tube, Realigned Back IF String
FHTRU-1V-C2	Inoperative	Replaced shorted C1 Capacitor in 11A Cell. Cleaned and Adjusted Relay
FHTR-1D (H)	No Signal	Shorted 2000 MMF Capacitor Replaced in Cell 3 and 16. Realigned Unit.
NA110A	Inoperative	Replaced Broken R-25 Resistor
NA110 B-2	Inoperative	Loose Battery Terminal Repaired
P33-2	Low Audio	T3 Coil Open. Replaced Coil and Realigned Set.

MOTOROLA EXPANDS DALLAS QUARTERS

Construction of a new Dallas, Texas, administrative headquarters for the 10-state southern sales area of Motorola Communications & Electronics, Inc., has been completed according to Edward L. Falls, Jr., Vice President and area manager.

The 12,000 square foot building houses a 2-way radio sales office, an expanded Motorola Parts Depot and a microwave and industrial control sales office, as well as the administrative office of the southern area. Address of the new facility is—7138 Envoy Court; Dallas 35, Texas. The telephone number is Fleetwood 7-3923.

The building and a parking area for 42 cars have been constructed on a 42,000 sq. ft. tract of land in the Brook Hollow Industrial District, about five miles from downtown Dallas. » » »



New Dallas offices of Motorola Communications and Electronics, Inc. will house administrative headquarters for 10-state southern area as well as microwave and 2-way radio sales offices and an expanded Parts Depot.

Are You Protected?

Safety of vehicles left in your care is your responsibility. This is one of many reasons for having your insurance checked often to be certain of adequate coverage.

This is anything but a "do-it-yourself" project. Most of us cannot make an objective analysis of the subject for several reasons. First of all we are biased in what we might term, in error, our own behalf. Secondly, with a few exceptions, we are not sufficiently well-informed on insurance matters to do justice to the seriousness of the problem.

All of us should seek competent advice on the types of coverage and the limits to be carried in consideration of the nature of our work and our size of operation. Also, do we want to grow, or do we want to be hobbled for a long period while laboring to satisfy a judgement? See your insurance agent this week. » » »

GORDON F. BENNETT, INC.

(Continued from page 1)

Before long, a 50 x 175 foot building was erected at 945 Niagara St. The "drive through" facility features electrically controlled doors with a clearance of 14 feet—making it capable of handling almost any vehicle on the road.

On one occasion, four pieces of fire equipment were being serviced at the same time in the building. This array of equipment included a 100-foot aerial ladder truck. Large trucks, including ready-mix units, can be handled with equal ease.

This drive-in feature is particularly valuable to Bennett, since the firm's operation consists of about 90 percent drive-in business. Contrast this with the limited space and four benches which Bennett boasted 10 years ago.

In addition, the company operates three mobile service units which will be equipped with two-way radio operating on 450 mc citizens band.

Bennett also has provisions for 5000 sq. ft. of parking space at the building's exterior. There are 1225 sq. ft. of service shop space; 1000 sq. ft. in a parts stock area; and 7250 sq. ft. for installation and drive-in service. The company utilizes spaces below trusses of the building for antenna storage.

Some of Bennett's key accounts include:

Van Dyke Taxi and Transfer Company;
City Service Taxicab of Buffalo, Inc.;
Niagara Frontier Transit System;
Pinehill Concrete Mix Corporation;
Erie County Water Authority;
Madison Taxi Service, Inc.;
Buffalo Gravel Corporation;

This ready-mix truck is only one example of the many vehicles Bennett services daily in its modern quarters.

Automobile Club of Buffalo;
Riverside Service Corp. (Trucker);
Erie County Sheriff;
Bethlehem Steel;
Railway Express Agency; and
Linde Air Products Co. » » »

RESULTS OF MSS POLL

	MSS's at Time of Poll	MSS's Responding	Service Personnel	Administrative & Clerical Personnel	Total
New England	46	41	123	48	170
Middle Atlantic	68	66	276	102	379
East North Central	172	158	371	138	509
West North Central	110	96	247	100	347
South Atlantic	86	83	298	106	404
East South Central	64	62	127	68	195
West South Central	123	105	290	127	427
Mountain	78	73	154	72	226
Pacific	75	74	266	125	395

The photo at the right was snapped at a recent party given by the Mobile Radio Maintenance Company of Whittier, Calif., for its staff members and their respective families.

national MOTOROLA RADIO COMMUNICATIONS service

The DISCRIMINATOR

Published by Motorola Communications & Electronics, Inc., a Subsidiary of Motorola, Inc. 4501 W. Augusta Chicago 51, Ill.

VOL. 5
NO. 1
Mar.-April, 1958

SO BIG!

by JOHN TANSEY

A 93.2% response to our recent MSS poll indicates the force of the "average" Motorola Service Station to be:

a) two F.C.C. licensed personnel
b) one non-licensed technician
c) one person devoting half time to administrative work
d) one person devoting ⅔ time to office or clerical work

This information from 758 MSS's is quite a contrast to the 1952 picture, when Motorola had 550 service stations, at which time the MSS's were just starting to break through from a one-man to the two-man operation.

Extrapolating the response of 758 MSS's to our force of 800 stations we estimate more than 3,300 persons employed in our nationwide service organization.

These figures conjure many impressive mental pictures. A person with military experience could conceivably picture three battalions in a dress review; a traffic man would picture 1650 communications service vehicles bumper-to-bumper, each bearing two persons, the column extending over six miles in length; an educator would muse on the number of schools and colleges necessary to provide the equivalent education and training acquired by this large force; and a city planner would exhalt in planning a community for 3,300 persons.

Another point indicated by our poll is that our field service organization is tremendous in its scope—virtually without comparison in the industry. This fact is graphically illustrated in the poll results (see page four), and further exemplified by our photograph on page four. In the photo are the members and families of the Mobile Radio Maintenance Co., Whittier, Calif., a company whose operations were covered in the first "Discriminator" issue.

GORDON F. BENNETT, INC.

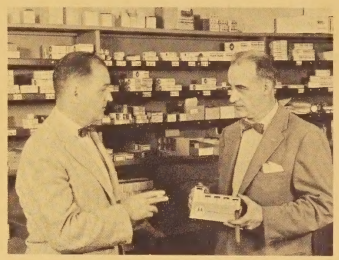
BUFFALO, NEW YORK

The story of Gordon F. Bennett, Inc., Motorola Service Station in Buffalo, New York, is one of phenomenal growth. Since starting operations in a two-car garage and servicing 25 mobiles 10 years ago, business has boomed for Bennett.

The firm now boasts an 8700 sq. ft. building which it occupied two years ago. In addition, a second-floor office has 1500 sq. ft. Clients have soared, until Bennett's total number of mobiles serviced in 1957 were well over 900 units! Since 1953, the number of mobiles serviced has been increased by 600 units, with a continued promising future outlook.

Gordon Bennett, president-treasurer of the company, attributes a large part of its growth and development to the backing and encouragement of Motorola and the Motorola salesmen operating in his territory. Bennett services Buffalo and Erie County.

Fresh from an association with Cornell Aeronautical Laboratory as an electronic instrumentation technician, Bennett started in the radio service business in 1931. He became a Motorola MSS in July, 1947. In March of that year, he installed and maintained the City Service Taxi Cab radio system, the first such commercial installation in Buffalo.



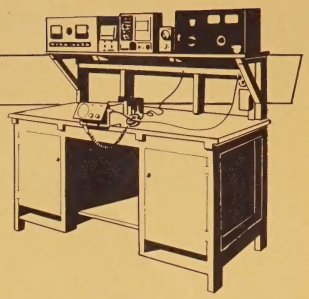
Above, John Tansey (left) National Service Manager for Motorola, and Gordon F. Bennett, President-Treasurer of the Corporation bearing his name.

As two-way radio increased in popularity in Buffalo, Bennett began receiving a lion's share of the servicing business. He enlisted the aid of his wife as vice president and George J. Trimper as secretary and legal counsel. The remainder of his organization consists of three men with FCC licenses of second class phone or better, two installers and an accountant, Miss Barbara Stanikunas, and Robert C. Smith, lead technician.

(Continued on page 4)

Provisions for adequate drive-through facilities were provided by the Gordon F. Bennett Company two years ago when the firm moved into new 8700 square foot quarters.

THE SERVICE BENCH



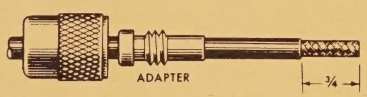
BY JOSEPH P. JATIS, MANAGER
TWO-WAY SERVICE TRAINING

HOW TO ASSEMBLE CABLE TO NEW CONNECTOR PLUG AND ADAPTER

A new plug is now incorporated into each of the assembly to cable assemblies of the TU316, TU308, and TU265 antennas. Numbers of the new plug assemblies are: Part No. 13—Connector, and Part No. 14—adapter. Accompanying illustrations and instructions further outline use of this equipment.

Step 1—Disassemble the connector plug.

Step 2—Cut off end of cable squarely. Remove ¾" of vinyl jacket.

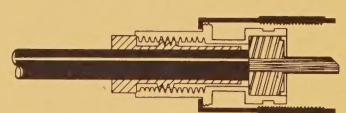


Step 3—Slide coupling ring and adapter on cable.

Step 4—Fan braid slightly and fold back as shown.

Step 5—Position adapter to dimension shown. Press braid back over body of adapter and trim to ⅜". Bare ⅝" of conductor. Tin exposed center conductor.

Step 6—Screw adapter into body of plug sub-assembly. Solder braid to body of plug sub-assembly through holes. Solder center conductor of cable to plug contact of plug sub-assembly.



Step 7—For final assembly, screw coupling ring on plug sub-assembly.

MOTOROLA'S 1958 PARTS CATALOG

The 1958 edition of the Motorola Communications Buyer's Guide should be in your hands now. This year's publication is considerably enlarged and includes a wealth of information which makes it the most complete catalog available of communications parts, kits, chassis, test equipment and accessories.

Entire new sections have been added, covering not only the normally required replacement parts and equipment, but also many kits and accessories that can be used to make existing communications even better. You'll find this catalog a handy reference source that will save you valuable time. If you need additional copies, write to your Motorola Parts Depot or the Factory Parts Department in Chicago. » » »

PORTABLE RADIOPHONES STOLEN

Two "Handie-Talkie" portable radiophones, Model FPTR 1HL-1, serial numbers 2048 and 2041, have been reported stolen from the Jonesboro Ranger District, Illinois. Any information about these units should be reported to C. L. Harrison, Forest Supervisor, U. S. Forest Service, Rolla, Missouri. » » »

quency currents. As time passes, they become less able to bypass the RF currents and start mixing them instead. This results in radiation on a number of frequencies instead of chiefly on one.

Usually, most of these spurious frequencies are close to the correct one and are probably separated from the original by multiples of 120 cycles, hence there may be little carriers everywhere. There may or may not be complaints that your customer is on the wrong frequency, or, the modulation may be low, or, there may not be quite enough power on the right frequency to do the job the equipment once did. Usually, the measured power output is satisfactory or even a little higher than usual, because some wattmeters don't care at all what frequency the power is on so long as it is power.

Again, the answer is: LISTEN TO YOUR WORK! Do it with headphones and your frequency meter. There should be only one clean carrier whistle—not two or three or fifty closely spaced near the right frequency. If you hear more than one, replace the electrolytic capacitor block associated with the modulator.

Rule No. 2—Check Your Meters.

Probably more time has been wasted fruitlessly in radio shops through implicit belief in the accuracy of meters than in any other way. It is just fine to have good test equipment, but better to keep it that way. For some unfathomable reason, many technicians come to believe that their test equipment is irreproachable and could not be guilty of error. Such is so far from the truth that it is amazing the amount of time that is spent tracing trouble that does not exist, simply because some instrument has developed trouble unknown to the user.

Considering the lack of care and rough treatment given to some instruments, it is remarkable that they work at all. All instruments should be given a thorough overhaul and be subject to complete recalibration not less than once a year and once in six months would be much better. Volt-ohmeters should be given a quick check at least once a month. Whenever tubes are replaced in any test instrument, the calibration becomes suspect.

If several voltage sources seem to be incorrect, check your meter before doing anything radical. If several stations seem to be off frequency at the same time better check your meter. If line voltage seems consistently high, better check your meter against that used by the power company; chances are that their meter is right, yours wrong.

One of the most essential of meters that requires frequent recalibration is your deviation meter. It is always difficult to make two such meters, even when of the same make and model, read the same every time. This is partly because we make such measurements with a variable, inconsistent source—the human voice. To get even close to repeatable, consistent readings, a stable, pure sine wave source should be used. Even then you must be careful of line voltage, temperature and carrier levels or your calibration check may be meaningless. Not all meters are this ticklish but better be careful, many are.

Frequency meters are always suspect too, even though you always check against the built-in crystal reference. It is still necessary to check regularly against WWV to see if your crystal is right.

Rule No. 3—Make Multiple Tests—Not Just One.

For years we have tested 2-way communication systems by asking for a ten count. It has become traditional. This is a good test but not nearly good enough. If successful, it merely proves that if you push the button once and count to ten, the carrier comes on and the modulation is applied successfully. It is a once over lightly test, proving very little. In numerous cases, troubles are present for long periods, undetected by the technician but loudly proclaimed by the customer. Trouble has remained undetected largely because of the inadequacy of this test. A vastly better test is as follows: Press the button and say, "ONE", then release the button. Ask the person on the other end to repeat after you, each figure that he hears, one at a time. Press the button again and say, "TWO", then release the button and await acknowledgment from the recipient. Continue thus to ten, or more.

This is a stringent test because it is multiple, it tests everything both ways at least ten times and gives time for troubles to show up, especially if they involve keying or relay troubles and various sorts of intermittents. If you missed one or more numbers in either direction, don't you dare kid yourself that somehow somebody failed to push a button soon enough or too soon—make darn sure you or they didn't, then start looking for the trouble.

Persistent troubles can be found quickly by similar tests—especially faulty relays. Any test of a relay that involves less than 25 complete operation cycles is poor work.

When testing a relay after repair, replacement or when just looking for trouble, put it through its paces at least 25 times, 50 times is better. Do this by applying the normal voltage on the coil in the normal way, with an ohmeter connected across the terminals to make sure the resistance goes from infinity and back to zero each time. If there is one failure in fifty, either replace the relay or adjust it to eliminate such failures. (Note: Remove the RF and DC voltages from the relay for this first test to avoid shock and meter damage). Make sure your connections to the meter are tight so no possible slip can allow you to assume that a poor connection explains a momentary failure under test. If you really want to find the trouble, make it impossible to rationalize yourself out of the problem during the test.

Now, disconnect the meter and test the other functions of the relay in the same manner. If it is an antenna relay, be sure to test both the receive and transmit sides. With the meter off and the circuits restored, give it a multiple test into a wattmeter. The whole idea is to give intermittent conditions as much time as possible to manifest themselves through multiple tests. If other relays are possible sources of trouble, make sure as many of them are included in the test at one time as possible. The author has been wonderfully successful with this method and troubles that had been present but un-

found for months were located in a few minutes.

Rule No. 4—Let the Same Technician Service the Same Customer Each Time Unless He Is Consistently Unsuccessful.

If equipment servicing is carried out each time by a different person, there will be no continuity of thought, no repeated observation of the unit's performances, and no pride in doing a good job will develop.

Radical changes in the performance of the system may go unnoticed because each new technician is unfamiliar with the usual performance. Troubles suspected, though unreported, may have to appear many times before anyone may react and look far enough and deep enough to locate them. On the other hand, if a man works for a considerable period unsuccessfully on a known trouble, there should not be the slightest hesitation in pulling him off and substituting another. The second man may locate the trouble almost immediately, not because he is better qualified but because his approach is different, and the first man might do the same for the second, if the situations were reversed.

Rule No. 5—Use Two Men On Difficult Problems.

Use of more than one man may seem to be wasteful of manpower but many difficult problems of communication that might take one man days to solve can be solved in minutes by having two qualified observers, even though they are both working on the same piece of equipment. What one man fails to observe, the other may, and together, they add it up to the right answer. This is especially true with repeater or station-to-station troubles where the technician formerly had to depend upon dispatchers or other untrained and disinterested persons to report back to him what happened.

Rule No. 6—Be Careful— Your Poor Grounds Are Showing.

It is somewhat unfortunate that most 2-way communication equipment uses antenna systems that do not involve the earth as one of the necessary elements, because while the system will usually work without a direct external ground, many a fleeting, hard to track down trouble may be alleviated by the use of a ground. The ground is desirable particularly from the standpoint of safety and also from the standpoint of reliability. If static discharges enter or leave by way of the antenna system, they will do less damage if there is a good ground on the tower, the metal building, if such is used, and on the transmission line and equipment cabinet. Frequent damage from lightning, telephone line noise, hum and sing can often be reduced by a good ground. All the equipment is safer if properly grounded.

One might suppose that absence of a ground would prevent the equipment from operating. Unfortunately, the fact that the metal case of the equipment is more or less grounded in most cases, and the fact that the transmission line is also usually grounded, assists in providing enough current to light the tubes, but hardly enough for proper operation in other respects.

All the current entering the set from the battery should enter through the heavy cable provided —not through the transmission line or the case. Often the "A" battery ground cable is not even connected. Actually, it should run direct to the battery or at least to the frame where a firm, permanent, low resistance connection must be made. This lead is designed to carry the DC current only—no RF, ignition noise or other strays.

Conversely, the ground on the transmission line should carry all the RF energy and none of the DC. Some way must be found to ground the shield as soon as it emerges from its sheath at the antenna end. It must be made firmly and well in every case or the antenna will not radiate properly. The length of this ground lead should be zero. No more than the absolute minimum of braid length should be used. A ground lead here more than one inch in length is bad; two inches almost impossible to make work properly. (Reference is made to low-band, ¼ wave systems, since the shield is continuous on higher frequency equipment.)

Grounding of the metal case of two-way equipment is desirable but not absolutely required. Connection between the case and the radio chassis may be random and uncertain, so it should be grounded to drain static charges collected upon it, but otherwise, it should not be a part of the DC or RF circuits. The cable ground should at all times be used to ground the equipment to the car frame.

Equipment operated from AC

2-WAY RADIO UNITS REPORTED MISSING

The Georgia Forestry Commission has reported theft of two Motorola Mobile FMTRU-41B 2-way radio units carrying serial numbers of 1064 and 1446. Information on these 25-watt sets should be forwarded to George Bishop, Chief Forest Administration, Georgia Forestry Commission, Box 1183, Macon, Georgia.

The Wright Construction Company of Lansing, Michigan, has reported theft of a TA-270MT Motorola Remote Control Console, carrying serial No. E-1510, and a TU-533A microphone. Information on these units should be sent to Wright company in Lansing.

Industrial Electronics of Chicago has reported theft of the following 2-way radio equipment: three T43GGV mobiles with serial number 7922; one FMTRU-140D mobile, serial No. 1061; one FMTRU-41V mobile, serial No. 1238; and one FHTRU-1D "Handie-Talkie" radio, serial No. 1614. Information on these units should be sent to Industrial Electronics at 5300 W. Harrison Street in Chicago, Illinois.

Three model H11-11H "Handie-Talkie" radiophones have been reported missing from the field office of Tipton and Kalmbach, Inc. Serial numbers of these units are 2977, 2979 and 2980. Information on these units should be forwarded to J. F. McKinney, Office Manager, Tipton and Kalmbach, Inc., 831 Fourteenth Street, Denver, Colorado. » » »

lines should always be grounded for safety and for proper operation. Example: Conelrad receivers. If a ground is not provided, the AC lines themselves will try to operate as a ground and thus become a part of the antenna circuit. As a result, operation of the equipment is likely to be quite inconsistent and noisy. There may be so much noise and hum modulation on the carriers received as to make them unusable and hardly a reliable source of life and death information.

Lack of a separate ground may also allow RF energy to enter directly through the power transformer without benefit of front-end selectivity and automatic volume control circuits. As switches are thrown, the effective length of the circuit involved changes radically, causing uncontrolled changes in volume. Several local stations mixed together may be heard or the modulation may be highly distorted. A good ground plus one or two AC line bypasses corrects all this.

In high-frequency RF circuits, grounds present different problems. Not only how and where the ground is made but also displacements of as little as ¼ of an inch may be important, since the length of a tuned circuit may be changed by where a bypass condenser is returned to ground. Be sure to ground things exactly where you found them and not somewhere nearby that might be more convenient.

Power supply circuits may be nearly as touchy as high frequency circuits with respect to the proper placement of grounds, because large hum and vibrator hash currents are circulating in the metal chassis and small potential differences develop between points only a few inches apart. If the correct point is not used for a ground, comparatively large hum and hash voltages may be introduced into sensitive grid circuits of audio amplifiers resulting in large hum output in the speaker.

Be wary of changing ground points in power supplies and in the input circuits of high gain audio amplifiers. Using the same ground point as in the original design will usually result in satisfactory operation. These precautions apply particularly to the point of connection for the shields around microphone cords and explains the necessity for a separate ground return wire for many microphone circuits. It is undesirable to have any currents flowing in a microphone ground wire other than those generated by the microphone itself. If such wires become grounded at any points other than those intended the hum or vibrator hash may become excessive.

A chance ground on a microphone ground lead inside of a mobile control head may cause excessive vibrator hash on the transmitter signal, yet, it seems a most unlikely cause since the lead in question is grounded anyway when it gets into the transmitter. The cause of the hash is due to the relatively large difference in potential of hash voltages along the car body between the front-mounted control head and the rear-mounted equipment. Actually, a ground point only a few inches from the correct one may be sufficient to cause trouble because microphone circuits, especially high impedance ones, are very sensitive to small voltages.

Hence, the shield around microphone leads though carefully grounded at some particular point is carefully insulated from ground in its travels all the way from the transmitter and through the control cable to the control head. Even the cartridge inside the microphone must be carefully insulated on both sides of the circuit or hum will result. In looking for this kind of trouble, disconnect the control cable in the rear and check for continuity to ground on either lead going to the microphone. They should be clear and of infinite resistance. Now, have an assistant twist and poke the cable from end to end and give the control head a poke and prod test, also the microphone to make certain that all is clear.

Rule No. 7—Be Careful— A Wattmeter May Read Incorrectly.

The fact that nearly everyone nowadays has and uses the Thruline wattmeter is a mixed blessing. It is highly desirable to know how much power is going TOWARDS the antenna as well as AWAY FROM it, and this job a Thruline wattmeter does very well. But this same wattmeter is so temptingly easy to use that almost immediately every technician succumbs to the idea of using it to tune a mobile or other unit to its antenna. This is a commendable idea only when the REFLECTED POWER IS VERY SMALL, seldom the case with low-band mobile installations.

If the inserted meter were used to prune the mobile whip to a minimum reflected power at the time of original installation, everything would be fine. Usually, this is not the case and a considerable reflected element remains. This means that the insertion of the meter with the necessary bit of patch cable will disturb the tuning greatly, and when the Thruline meter is removed, the transmitter may, in fact, be operating very poorly, much worse than it would have worked had the unit been tuned in the time-honored manner with a Motorola Test Set.

In most cases, with low-band equipment, the transmitter must be retuned with a Test Set after the wattmeter is removed, simply because there is some appreciable reflected power, and changing the line length changes the tuning radically. This same fact also applies to low-band base stations if there is appreciable reflected power. When this is the case with a ¼ kw station, the small air condenser in series with the pickup loop should be unshorted and put to use. That is what it is there for. Smaller base stations always have such a condenser in the circuit from the start, as do all mobiles excepting 450 mc equipment.

MOBILE COMMUNICATIONS SERVICE

(Continued from page 1)

door at the front and a 10-foot overhead door at the rear.

The garage has sufficient space so that two cars can be serviced inside, with additional room for three more cars on the driveway inside the building. At the rear of the facility is parking space for eight cars. Shop space provides for three 10-foot service benches fully-equipped for the most efficient operation and parts storage, tool racks and related equipment.

A special feature of the shop is the 6 x 6-foot screen room used for phasing and analysis. Metering and test facilities are also provided on two of the three benches outside the screen room, making it possible for three technicians to work on as many units at the same time.

Added refinements are the two fully-equipped offices inside a partitioned area. Both shop and office spaces are air conditioned, and comfortable seating facilities are provided for customers awaiting repairs. In addition to these facilities, the firm has a branch operation at 412 N. 18th Street in Omaha.

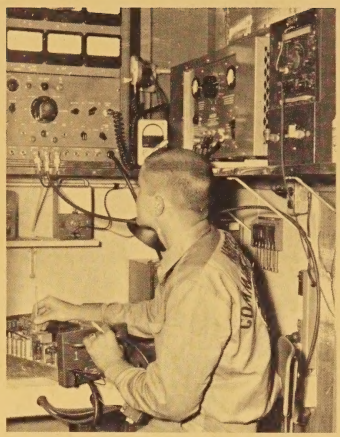
Some of the salient points regarding use of the screen room are: test equipment that provides simultaneous metering of all receiver or transmitter positions; a 100-ampere DC power supply; common control head panel with cables for all models; high and low band Motorola frequency monitor; Termaline and Thruline wattmeters, Model 80R signal generator; three VTVM units; coax patch board and many other labor-saving test set-ups.

A new Ford panel courier used for service calls carries portable test equipment and parts. In the field, sets are checked and serviced through use of a Motorola portable test set. Any units with serious malfunctions are brought to the shop for repairs. Each of the company's technicians carries a portable test set and a tube caddy in his personal car for use during night service calls or similar emergencies.

The growth of the company has been a steady, evolutionary one. As 2-way radio customers in the area grew and expanded their systems, Mobile Communications added to its own facilities. The space rented in the Yellow Cab building in Topeka proved too small for the growing volume, thus precipitating erection of the new building.

The partners point out that their business operates on the premise that what the customer needs and wants should be provided as efficiently and as quickly as possible. The firm's large inventory of parts is dedicated toward this end.

A perpetual inventory of parts is kept in a loose leaf binder, giving optimum control over purchases. In this way, it takes just a glance to determine how many of any particular item have been sold during a given period and the proper number which can profitably be kept in stock.



Frank Fernald uses modern screen room to repair unit in intermittent condition. Simultaneous metering is used to check all circuits of both transmitter and receiver. Screen room contains a 100 amp DC power supply.

The record also is invaluable in purchasing, since a six-month or year's supply can be retained without being overstocked. Rarely does the company run out of an item with the result that a rush order must be sent to the factory. Ready availability of parts is a service offered both to customers and to other 2-way radio users who maintain their own equipment.

A look at company activities reveals that 75 percent of all work is done at the shop. Work done at customer locations represents 20 percent, while the remainder is miscellaneous. About 75 percent of the operation is Motorola subcontract business.

Some of the major accounts serviced by the Mobile Communications Company are:

Topeka Accounts: Topeka Police Department, Shawnee County Sheriff, Yellow Cab Company, Union Cab Company, Gas Service Company, City Water Department, City Street Department, Kansas Turnpike.

Omaha Accounts: Omaha Police Department, Omaha Fire Department, Checker Cab Company, Yellow Cab Company, Council Bluffs City. » » »

Radio in cab is repaired while driver waits. Note frequency and deviation monitor built into wall at right for giving speedy frequency checks. The near-by air-hose permits quick cleaning of dust from customer's unit.

Expansion, research advances, and addition of new products marked another year of progress for Motorola's Semiconductor Products Division. Dollar sales increased over 40% in spite of the chaotic price competition within the industry. Increased volume offset price reductions, and earnings were maintained at about the favorable level of the previous year.

In May, 1961, the Division expanded its research and production facilities with the opening of a 315,000 square foot addition. This more than doubled its previous operating area, and the facility now has a total of some 536,000 feet.

During 1961, the Division concentrated on the engineering improvement and production expansion of its broad line of semiconductor products which now includes some 4,000 different types. The Division effected major engineering and process improvements in the germanium mesa transistor line, resulting in significant reductions of cost and increases in reliability.

These improvements are being incorporated into the production techniques used in making all Motorola mesa transistors.

Motorola's accomplishment in developing and implementing practical production methods of epitaxial crystal growth has made possible a universal line of high-speed switching transistors. The line literally blankets the major spectrum of computer applications. The epitaxial technique has also enabled the Division to introduce new germanium amplifier transistors which compete in the high-frequency communications market.

The Division introduced the new epitaxial star planar silicon transistor which represents the ultimate in design for maximum operating performance, frequency range, and reliability. It permits a combination of electrical parameters not before possible in a single device. The star planar incorporates in one transistor all of the latest semiconductor technologies, providing Motorola the capability to advance integrated circuit activity.

All silicon mesa transistor production lines were converted to the epitaxial process during the year.

The Semiconductor Products Division strengthened its position in the industrial and military markets with the addition of a new power transistor design. This provides superior power capability over competitive types. With the inclusion of the devices used in automotive products, Motorola has the most complete line of power transistors currently available.

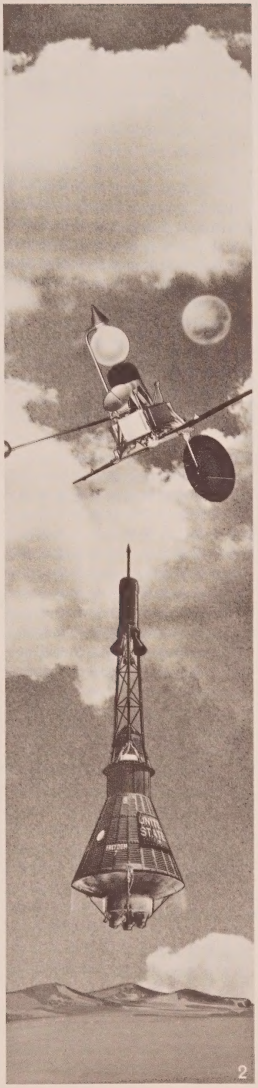
For the expanding automotive market, Motorola's early development of a low-cost silicon rectifier resulted in the capture of a major part of the volume in this device. The silicon rectifier has made the electronic alternator an economic replacement for the automobile DC generator.

Expansion of the zener diode line to include new devices has established the Division as the leading supplier, having the most complete line in the industry.

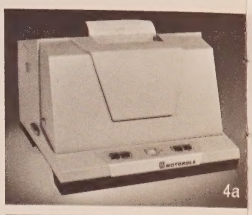
Two years of research effort in microminiature solid-state technology, coupled with new advances in the epitaxial technique (considered vital for the fabrication of integrated circuits) qualified the Division for a $1.5 million Air Force contract for accelerated research and development in this new art. This work—undertaken in cooperation with the continued research in this field by the Solid State Systems Division—is expected to result in maintaining a leading position in the revolutionary technology of integrated circuitry.

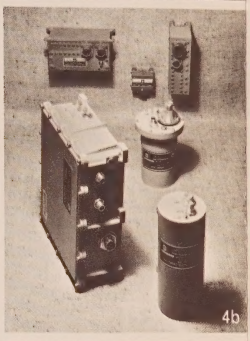
Motorola has developed several practical integrated circuit devices which will be introduced early in 1962 for both military and industrial applications. The devices are unique in that they can be used to replace conventional circuits in existing equipment without requiring complete redesign of equipment to conform to the special requirements of integrated circuits.

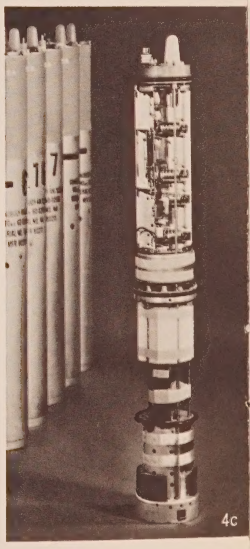
MILITARY ELECTRONICS DIVISION



A montage of representative "end-uses" of Motorola Military products: (bottom to top) **1**/*Data Acquisition* and *Telemetry System:* relays in-flight information from "X-15" manned space probe. **2**/ *Space Guidance, Command & Control Systems:* command functions system for Mercury capsule; guidance and command functions system for Ranger space craft. **3**/ *Tactical Communications Control and Sensor Equipment:* advanced single-sideband communications system for Army; command and control digital data link used in Navy's anti-submarine warfare system; advanced reconnaissance sensors (APS-94); drone-mounted sidelooking radar. **4**/ *Expanding Proprietary Product Line:* (a) electronic teleprinter; (b) family of command receivers and long-range radar transponders; (c) sonobuoys—undersea warfare equipment.







Sales of the Military Electronics Division maintained about the same level as the previous year although the Division reported a major improvement in operating results. The backlog of military contracts rose substantially, establishing a six-year high at the close of 1961.

Current major programs conducted by the Military Electronics Division are serving the armed forces, the National Aeronautical and Space Administration (NASA), the Federal Aviation Agency (FAA), and many prime industrial contractors.

Proprietary product development has assumed an important role at each of the Military centers in Chicago, Illinois; Phoenix, Arizona; and Riverside, California. Emphasis on the generation of these new devices has resulted in contracts with improved long-range production potential.

Prominent among the proprietary products is a family of Motorola "Command Receivers"—used or scheduled for use in more second generation missiles than any similar competitive receiver—and an expanded line of radar transponders used in tracking long-range missiles and spacecraft.

Design-approval models of the Army's AN/USC-3 "Communications System" were delivered in late 1961 for field evaluation. The production pace on this multi-million dollar contract will be stepped up during 1962. The research and development phases of the Motorola-designed APS-94 "Side-Looking Radar" have been completed, and assembly has started on production models of this highly advanced reconnaissance equipment.

The data acquisition and relaying equipment used in picking up in-flight information from the "X-15" manned space probe vehicle was installed on the first half of the test range near Edwards Air Force Base. Designed by the Riverside Systems Research Laboratory and employing microwave relaying units supplied by the Chicago Military Center, this first segment of the complex data transfer system was accepted as operational by the Air Force and will be used jointly with NASA. Construction of the second half of the system is continuing into 1962.

A new, fully-transistorized microwave product line consisting of RF and multiplex equipment was entering into production at the Chicago Center at year's end.

The Chicago Center delivered to the Navy the first prototypes of an all-solid-state radar indicator. Production quantities of these units will be supplied during 1962.

Other important programs performed during 1961 included the digital data link supplied for the Navy's DASH drone helicopter; a substantial contract for Motorola-designed teleprinter units for use by the Strategic Air Command; and continuing large-volume production of Sonobuoys (under-sea detection devices).

A long-range planning group has been established to study and monitor Air Force and NASA needs for aerospace systems extending into the 1970's. Prominent among the space programs in which Motorola is now participating are the "Mercury," "Saturn," "Ranger," "Mariner," "Advent," and "Midas" programs. In the missile area, Motorola equipment is found on nearly all present and proposed missile systems including "Atlas," "Minuteman," "Pershing," "Polaris," "Bomarc," "Quail," "Sidewinder," and many others.

Indicative of the Company-wide emphasis on solid state integrated circuit implementation are the many advanced programs and techniques within the Military Electronics Division. A formal program is now in progress to assure earliest possible application of available integrated solid state devices to military systems and equipment. This program is closely coordinated with the Solid State Systems and Semiconductor Products divisions to place Motorola in position to aid the country's leadership in advanced military equipment and systems.

SOLID STATE SYSTEMS DIVISION

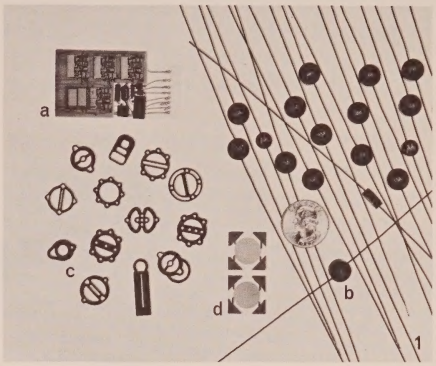
In order to acknowledge the increasing emphasis Motorola is placing on the program and mission of the Solid State Electronics and Controls department in the field of industrial products as well as in military solid state research, the department has been advanced to divisional status under the leadership of Dr. H. W. Welch.

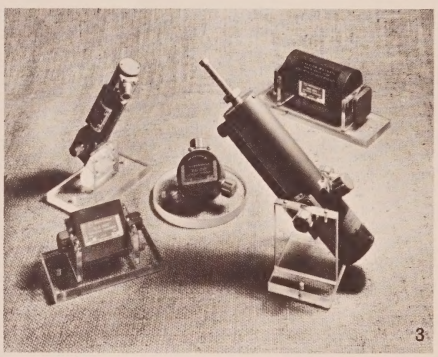
The primary mission of the new Solid State Systems Division is the application of solid state materials, devices, integrated circuits, and techniques to existing equipment and systems—and to develop new product applications of electronics. The Division is organized into three groups designated "Controls Department," "Electronics Department," and "Research Department."

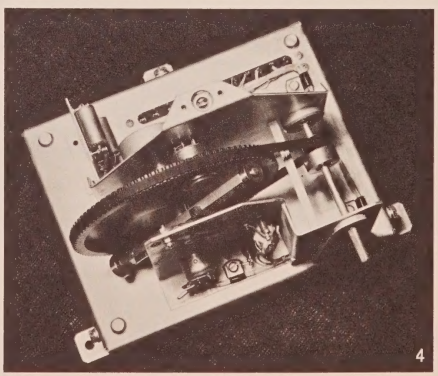
Industrial control system development, production, and sales activities will be carried on by the Controls Department. The first group of new products—designed for remote supervisory control of water, power, oil, and gas distribution systems—is engineered and in production. The first units were placed in the hands of customers in late 1961. A complete line of process control equipment will be released in 1962, and other solid state control applications are undergoing study and development.

The Electronics Department of the Division has on the market a complete line of electromagnetic devices for application in microwave communications and radar systems. Solid state instrumentation for control applications—from refrigeration to space satellites—is under development.

The Research Department will continue its exploration in the fields of electronic ceramics, thin film technology, and solid state device application. Special attention will be given to integrated solid state electronics in an effort to provide unique and advanced features in new products developed by other Motorola divisions.







Among the initial products developed and manufactured by Motorola's new Solid State Systems Division: 1/ (a) thin film voltage digitizer; (b) positive temperature coefficient thermistors; (c) multiaperature magnetic cores; (d) thin film magnetoresistive element; • 2/ "Telememory" supervisory control console; • 3/ a family of microwave devices • 4/ liquid level digitizer.

INTERNATIONAL OPERATIONS

For the third consecutive year, sales and earnings from Motorola products sold overseas have set new marks. Recorded was an all-time high with an increase in sales over the previous year of about 24%, and a substantial improvement in earnings.

An intensified licensing program, initiated in the latter part of 1958, is now producing results. Progress was made in 1961 in establishing manufacturing arrangements in France, Argentina, Brazil, and Mexico. Manufacturing arrangements in Canada also were strengthened and expanded. Assembly facilities were established in Chile, Uruguay, and Colombia. Total income from overseas licensing during 1961 surpassed any previous year.

Motorola currently is placing emphasis on developing production facilities outside this country through licensing and joint venture manufacturing arrangements. An international management and organization base has been established to provide a firm planning and marketing structure for this purpose.

A high percentage of international operations is in the sale of communications products. This trend is expected to continue and major attention is being directed at this market area.

Increased emphasis was given to the export sales of automotive and aviation products. Considerable attention also was directed during the year to engineering suitable consumer and communications products to meet the diverse needs of the major world markets. By the end of 1962 there should be visible progress in this program.

HEARING AIDS AND HOSPITAL COMMUNICATIONS

Indicative of the gradual changes taking place within the Company's hearing aid and hospital communications department is the new trademark establishing identification between the Dahlberg hearing aid group and Motorola. The trademark now appearing on all products and sales literature reads: "Motorola/Dahlberg Hearing Aids."

The Mark IV, a unique and efficient behind-the-ear hearing aid introduced this year, strengthened the Motorola/Dahlberg line of quality instruments. Notable expansion also took place in the sales department in anticipation of increased market activity in 1962.

The hospital communications department fortified its marketing position in 1961 by expanding and strengthening the product line. Additions included: a miniaturized low-frequency pocket radio pager; a low-priced hospital TV set; an inter-communications system; a doctor's register system; and a manual nurse-call system. These new products, added to the existing line of Motorola/Dahlberg hospital products, place the Company in the position of producing the most complete hospital communications line in the industry.

Sales responsibility for hospital communications systems was transferred during the year to Motorola's Communications Division for purposes of maximum market coverage, systems engineering, and service.

FINANCIAL REPORT

The annual meeting will be held on Monday, May 7, 1962. A notice of the meeting, together with a form of proxy and a proxy statement, will be mailed to shareholders on or about April 9, 1962, at which time proxies will be solicited by the management.

TRANSFER AGENTS: Harris Trust and Savings Bank
111 W. Monroe St., Chicago 90, Illinois

Chemical Bank New York Trust Company
165 Broadway, New York 15, New York

REGISTRARS: Continental Illinois National Bank and Trust Company of Chicago
231 S. LaSalle St., Chicago 90, Illinois

Irving Trust Company
1 Wall St., New York 15, New York

TEN YEAR FINANCIAL SUMMARY

	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
SALES AND OTHER REVENUES†	$169,191,047	219,089,238	206,821,801	228,428,063	229,266,055	228,431,385	218,909,968	293,081,127	301,049,185	298,219,845
INCOME BEFORE INCOME TAXES†	$15,576,165	15,512,489	16,523,889	18,740,426	16,936,334	15,756,431	15,171,013	27,756,237	26,548,813	19,900,308
EARNINGS	$7,012,700	7,076,335	7,572,024	8,490,539	7,966,817	7,824,431	7,356,213	14,171,237	12,633,813	9,517,308
EARNINGS PER SHARE*	$1.81	1.83	1.96	2.19	2.06	2.02	1.90	3.59	3.14	2.36
WORKING CAPITAL†	$38,007,247	38,222,001	38,308,612	42,892,165	54,936,569	56,425,360	59,585,830	63,336,998	73,790,019	95,078,616
NET INVESTMENT IN PLANT AND EQUIPMENT	$11,429,532	14,301,004	16,579,531	19,179,992	25,388,866	27,167,597	27,615,287	33,436,676	44,594,599	48,427,446
SHAREHOLDERS' EQUITY	$41,755,780	45,929,419	50,598,747	56,186,590	61,305,080	66,172,446	71,533,020	83,338,386	97,166,850	102,655,506

† Restated to include Motorola Finance Corporation, a wholly-owned subsidiary, organized in 1956 and not consolidated prior to 1961.

* Earnings per share are based on the number of shares outstanding at the end of the respective years, adjusted for subsequent share distributions.

Motorola, Inc. and Subsidiaries

STATEMENT OF CONSOLIDATED EARNINGS AND RETAINED EARNINGS

Years ended December 31	1961	1960
Sales and other revenues	$298,219,845	$301,049,185
Manufacturing and other costs of sales	214,871,908	218,874,056
Selling, service, and administrative expenses	52,409,790	43,649,804
Depreciation of plant and equipment	5,276,286	4,475,463
Contribution to employees' profit sharing fund	2,624,174	4,610,393
Interest and amortization of debenture expense	3,137,379	2,890,656
Total costs and other expenses	278,319,537	274,500,372
Income before federal income taxes	19,900,308	26,548,813
Federal income taxes	10,383,000	13,915,000
Earnings (per share outstanding at end of year: 1961, $2.36; 1960, $3.14)	9,517,308	12,633,813
Retained earnings at beginning of year	71,242,879	68,429,207
Total	80,760,187	81,063,020
Cash dividends declared (per share: 1961, $1.00; 1960, $.9375)	4,028,652	3,777,163
Share-for-share distribution—par value of 2,014,326 shares, transferred to capital stock account	—	6,042,978
Total deductions	4,028,652	9,820,141
Retained earnings at end of year (note 6)	$ 76,731,535	$ 71,242,879

See accompanying notes to financial statements.

Accountants' Report

The Board of Directors and Shareholders of Motorola, Inc.:

We have examined the consolidated balance sheet of Motorola, Inc. and subsidiaries as of December 31, 1961 and the related statement of earnings and retained earnings for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances. It was not practicable to confirm accounts receivable from United States government departments or agencies by communication with them but we satisfied ourselves as to such accounts by means of other auditing procedures.

In our opinion, the accompanying consolidated balance sheet and statement of consolidated earnings and retained earnings present fairly the financial position of Motorola, Inc. and subsidiaries at December 31, 1961 and the results of their operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Chicago, Illinois, February 21, 1962 *PEAT, MARWICK, MITCHELL & CO.*

DIRECTORS AND OFFICERS

ROBERT W. GALVIN
DIRECTOR, PRESIDENT

MATHEW J. HICKEY, JR.
DIRECTOR

DANIEL E. NOBLE
DIRECTOR, EXECUTIVE VICE PRESIDENT,
COMMUNICATIONS, SEMICONDUCTOR,
MILITARY ELECTRONICS, AND
SOLID STATE SYSTEMS DIVISIONS

FRANK J. O'BRIEN
DIRECTOR, VICE PRESIDENT, PURCHASING

ARTHUR L. REESE
DIRECTOR, VICE PRESIDENT AND GENERAL MANAGER,
COMMUNICATIONS DIVISION

WALTER B. SCOTT
DIRECTOR, VICE PRESIDENT,
CONSUMER AND AUTOMOTIVE PRODUCTION

EDWARD R. TAYLOR
DIRECTOR, EXECUTIVE VICE PRESIDENT,
CONSUMER PRODUCTS DIVISION

EDWIN P. VANDERWICKEN
DIRECTOR, VICE PRESIDENT FOR FINANCE,
TREASURER, AND SECRETARY

ELMER H. WAVERING
DIRECTOR, EXECUTIVE VICE PRESIDENT,
AUTOMOTIVE PRODUCTS DIVISION

ALEX ARNOLD
VICE PRESIDENT, CONTROLLER

ALLEN H. CENTER
VICE PRESIDENT, PUBLIC RELATIONS

JOSEPH A. CHAMBERS
VICE PRESIDENT AND MANAGER, WESTERN CENTER,
MILITARY ELECTRONICS DIVISION

JOHN I. DAVIS
VICE PRESIDENT,
CONSUMER PRODUCTS ENGINEERING

SYLVESTER R. HERKES
VICE PRESIDENT,
CONSUMER PRODUCTS MARKETING

C. LESTER HOGAN
VICE PRESIDENT AND GENERAL MANAGER,
SEMICONDUCTOR PRODUCTS DIVISION

HOMER L. MARRS
VICE PRESIDENT,
COMMUNICATIONS SALES

KENNETH M. PIPER
VICE PRESIDENT,
HUMAN RELATIONS

WILLIAM J. WEISZ
VICE PRESIDENT,
COMMUNICATIONS PRODUCTS

WILLIAM S. WHEELER
VICE PRESIDENT AND GENERAL MANAGER,
MILITARY ELECTRONICS DIVISION

MOTOROLA INC. / 9401 West Grand Avenue, Franklin Park, Illinois

MAJOR FACILITIES LOCATED IN: ARCADE, NEW YORK · CHICAGO, FRANKLIN PARK, AND QUINCY, ILLINOIS
MINNEAPOLIS, MINNESOTA · PHOENIX AND SCOTTSDALE, ARIZONA · CULVER CITY AND RIVERSIDE, CALIFORNIA

Motorola Products · **AUTOMOTIVE PRODUCTS** · CAR RADIOS · PUSHBUTTON TRANSMISSION CONTROLS · ALTERNATOR SYSTEMS · TRANSISTORIZED IGNITION SYSTEMS **COMMUNICATIONS PRODUCTS** · TWO-WAY RADIO — MOBILE, PORTABLE AND BASE STATION EQUIPMENT, PUSHBUTTON MOBILE RADIO-TELEPHONE, ANTENNAS, TOWERS, ACCESSORIES AND PARTS, CONTRACT MAINTENANCE AND INSTALLATION SERVICE · AUTOMATIC CAPACITANCE SWITCHING FOR ELECTRIC UTILITIES · **ELECTRONIC SIGNALING DEVICES** · CLOSED CIRCUIT TELEVISION EQUIPMENT · MICROWAVE RELAY SYSTEMS · RADIO TRAFFIC LIGHT CONTROL · RADIO PAGING SYSTEMS · POWER MEGAPHONES · **PRECISION TEST** AND MEASUREMENT EQUIPMENT · "SELCAL" SELECTIVE CALLING EQUIPMENT FOR AIRLINES · AIRCRAFT VHF NAVIGATION AND COMMUNICATIONS EQUIPMENT · **AIRCRAFT AUTOMATIC** DIRECTION FINDERS · AUTOMATIC FLIGHT CONTROL SYSTEMS **CONSUMER PRODUCTS** · TELEVISION RECEIVERS · STEREOPHONIC HIGH FIDELITY PHONOGRAPHS · **AM AND AM-FM TABLE** RADIOS · CLOCK AND PORTABLE RADIOS · AM AND FM CAR RADIOS · ALTERNATOR SYSTEMS, ANTENNAS, ACCESSORIES, AND PARTS **DAHLBERG PRODUCTS** · HEARING AIDS · HOSPITAL COMMUNICATIONS SYSTEMS **MILITARY ELECTRONICS PRODUCTS** · RADAR · COMMUNICATIONS SYSTEMS · MISSILE GUIDANCE SYSTEMS · INDICATORS AND DISPLAY SYSTEMS · ANTI-SUBMARINE WARFARE EQUIPMENT · DATA LINK SYSTEMS · NAVIGATION EQUIPMENT · TELEMETERING SYSTEMS · DRONE CONTROL SYSTEMS · GROUND SUPPORT, TRAINING, AND TEST EQUIPMENT · ELECTRONIC COUNTERMEASURE SYSTEMS · FLIGHT SAFETY EQUIPMENT **SEMICONDUCTOR PRODUCTS** · POWER TRANSISTORS · MESA TRANSISTORS · GENERAL PURPOSE TRANSISTORS · INDUSTRIAL AUDIO TRANSISTORS · INDUSTRIAL SWITCHING TRANSISTORS · RECTIFIERS · ZENER DIODES **SOLID STATE PRODUCTS** · PROCESS MEASUREMENT AND CONTROL SYSTEMS · REMOTE SUPERVISORY CONTROL SYSTEMS · ANALOG AND DIGITAL INSTRUMENTATION · ELECTROMAGNETIC DEVICES · INTEGRATED ELECTRONIC SUB-ASSEMBLIES.